



# Development of the Small-size Batteryless Absolute Encoder “RA035”

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## 1. Introduction

Encoders are position detection devices for servo motors. They detect the angle of rotation of the motor shaft and send that position information to the servo amplifier. If a servo system were a person, the motor would be the muscle, the servo amplifier the brain and the encoder the eyes. If the eyes cannot see well, the servo amplifier that serves as the brain and the motor that serves as the muscles cannot operate properly. In other words, the encoder is the essential element that controls abilities of a servo system. Additionally, the encoder represents added value and thus increases the convenience of the system. For example, if angle information including the motor's multiple rotation (multi-turn) information is output as an absolute value, there is no need for a return-to-origin operation on the device. Additionally, sending alarm information whenever the encoder is operating abnormally provides a failsafe for the system.

The newly-developed SANMOTION SENSOR “RA035” (hereinafter referred to as the “RA035”) is a batteryless resolver-method absolute encoder that outputs current position information including multiple rotation. This device is smaller than conventional products and can be mounted on a 40 mm square motor.

Section 2 of this document introduces the features of the “RA035”. Section 3 shows the specifications of the “RA035”, while Section 4 lists the applications for which the resolver method is well suited.

## 2. Features of the “RA035”

### 2.1 Use of the batteryless technologies developed for the “RA062” (1)

Applications that involve positioning through reducers such as robots and injection molding machines require absolute position information including multiple rotation. Output of absolute position information generally requires the use of an external battery.

Conventional absolute encoders provided power to the encoder from a battery when the power supply to the entire device was cut off. This allowed the movement of the motor shaft to be observed. However, the battery needed to be changed regularly, which increased maintenance time and the environmental load.

Additionally, batteries that were running out of charge often made errors by losing the multiple rotation information.

As a unique approach to solving this problem, we previously released the SANMOTION SENSOR “RA062” (hereinafter referred to as “RA062”), a batteryless encoder that outputs absolute position information, including the multiple rotation<sup>(1)</sup>.

The “RA035” makes use of new batteryless technology based on that developed for the “RA062”. Specifically, the encoder employs multiple interlocking gears and uses the physical relationships of the gears to determine the absolute position, including multiple rotation. The “RA035” has a set of gears for determining multiple rotation that allow it to be 30% smaller than the “RA062”.

### 2.2 Mountable on a 40 mm square motor

The “RA035” is centered around the ideas of “smaller” and “lighter.” Fig. 1 shows an image of a 40 mm square motor attached to “RA035”, while Fig. 2 shows a sketch of the same thing. Table 1 compares the dimensions of the “RA035” and “RA062”. The diameter of “RA062” is  $\phi$  62 mm and can thus only be attached to motors 76 mm square or larger. The “RA035”, on the other hand, has a size of 40 mm sq. and thus can be attached to motors as small as 40 mm square. The length of the encoder is 45 mm. The unit weighs 99 grams.

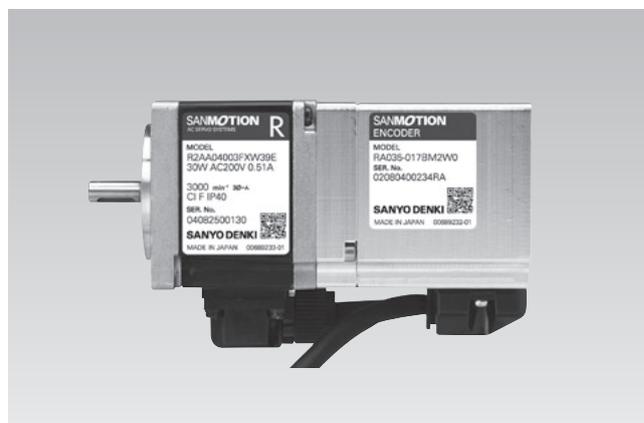


Fig. 1: Motor with “RA035”

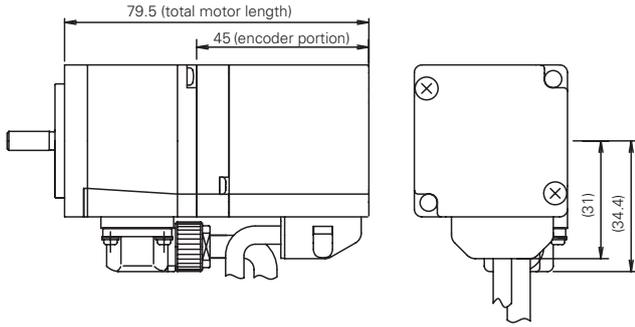


Fig. 2: 40 mm square, 30 W motor with “RA035” encoder attached

Table 1: Encoder comparison

	RA035	RA062
<b>Encoder size</b>	40 mm sq.	Φ 62 mm
<b>Attachable motor flange size</b>	40 mm sq. and up	76 mm sq. and up
<b>Encoder length</b>	45 mm	43 mm
<b>Encoder weight (excluding cover)</b>	99 g	160 g

### 2.3 Smaller Process Circuit

Fig. 3 shows a block diagram of the “RA035”. The “RA035” consists of a resolver and a control circuit. The two main parts of the control circuit are the analog ASIC that excites the resolver and synthesizes the waveform, and the FPGA that calculates and corrects the position data and handles communications. The functions of the digital ASIC and the CPU from the “RA062”, as well as the communications IC have been merged into the FPGA, both integrating and reducing the size of the unit.

The resolver unit of the “RA035” has 4 resolvers from RS0 to RS3. The analog ASIC activates the 4 resolvers in order. The FPGA takes the signal from the analog ASIC and converts it to position data, then sends the position data and status data to the servo amplifier in a specialized communication format.

The “RA035” corrects the position data in order to gather highly accurate position information. The position accuracy of the resolver is influenced by things such as variations in the impedance of the wire coil and in the mechanical alignment. These values are corrected electronically in the “RA035”. Specifically, product-specific correction data is saved for each unit in the flash ROM in the FPGA, increasing the accuracy of the device.

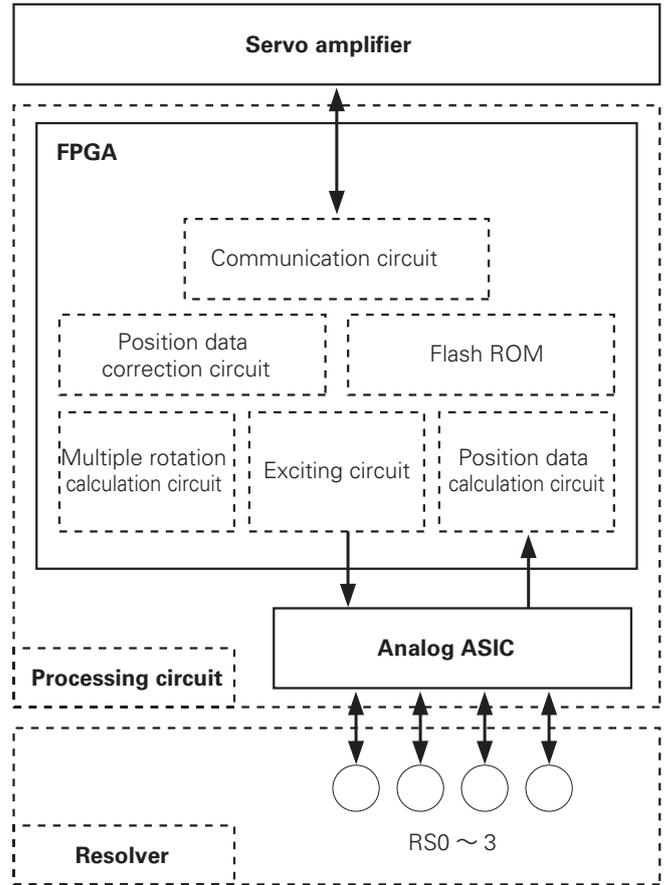


Fig. 3: Block Diagram of “RA035”

### 3. Specifications

Table 2 shows the specifications of the “RA035”. The accuracy of the absolute position is better than 10 minutes, approximately the same as an optical encoder. The resolution is 17 bits / rotation (131,072 divisions) and the multiple rotation is 14 bits (between -8192 and 8191).

Communication with the servo amplifier is handled via our company’s standard NRZ asynchronous transmission (A format) with a communication speed of either 2.5 Mbps or 4 Mbps. Batteryless design means that no battery wiring is required, so the wiring ends up being one pair for serial communication and one pair for the power source for a total of 2 pairs (4 lines) running between the encoder and the servo amplifier. This improves reliability and reduces the end user’s wiring and installation costs.

The “RA035” has a power consumption of 80 mA. This is less than half of the 170 mA consumed by the “RA062”. The reduced power consumption is due to the integration of the FPGA circuit and contributes greatly to the increased energy efficiency of the device. The LCA (life cycle assessment) indicates a savings of 12,000 Mcal per year and a reduction in CO<sub>2</sub> emissions of 190 tons per year compared to the “RA062”.

As this product offers reduced size and mass for a smaller environmental footprint, it has earned our ECO PRODUCTS mark. Fig. 4 shows the ECO PRODUCTS mark.

Table 2: RA035 specifications

	RA035
<b>Absolute position accuracy</b>	Max. 10 minutes
<b>Resolution</b>	17 bits/rotation
<b>Multiple rotation</b>	14 bits
<b>Communication format</b>	NRZ asynchronous transmission (A format)
<b>Baud rate</b>	2.5 Mbps or 4 Mbps
<b>Communication cables</b>	2 pair (4 lines)
<b>Current consumption</b>	80 mA



Fig. 4: ECO PRODUCTS symbol

## 4. Applications

Because the resolver is relatively simple to construct, it is has resistance to vibration as well as environment resistance characteristics, and is extremely reliable. The “RA035” has both reliability from its resolvers and accurate position detection and resolution from its optical encoder, making it suitable for use in harsh environments subject to heavy vibration or oil misting.

The “RA062” was only compatible with middle to large sized motors that are 76 mm square or larger, but the “RA035” is compatible with motors as small as 40 mm square. This means it can be incorporated into a wide range of application from small robots to devices that require several motors lined up in a row, such as drillers for print circuit board. Additionally, the “RA035” is compatible with the “RA062” and they can thus be exchanged without making any other changes to the system. Exchanging the “RA035” in any application currently using the “RA062” will result in smaller, lighter devices that consume less energy during operation.

## 5. Conclusion

This document has introduced the characteristics and specifications of the newly developed small-size batteryless absolute

encoder “RA035” and has noted the applications where this new device is useful. The development of the “RA035” strengthens our batteryless encoder lineup and makes use of our unique batteryless technologies. We believe that it will add new charm and value to the SANMOTION brand.

### Documentation

- (1) Kazuhiro Makiuchi, et al: Servo System Technology that Changes the Current Trend: Batteryless Absolute Sensor “RA062” SANYODENKI Technical Report No.16 Nov. 2003



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